United States Patent [19]

Elliott

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[54] **MAGNETIC SEPARATION MACHINE**

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[51] **Int. Cl.**[4] **B03C 1/14**

[52] **U.S. Cl.** **209/223.1;** 209/223.2; 209/224

[58] **Field of Search** 209/219, 223.1, 223.2, 209/227, 231, 232, 213, 224; 198/619

[56] **References Cited**

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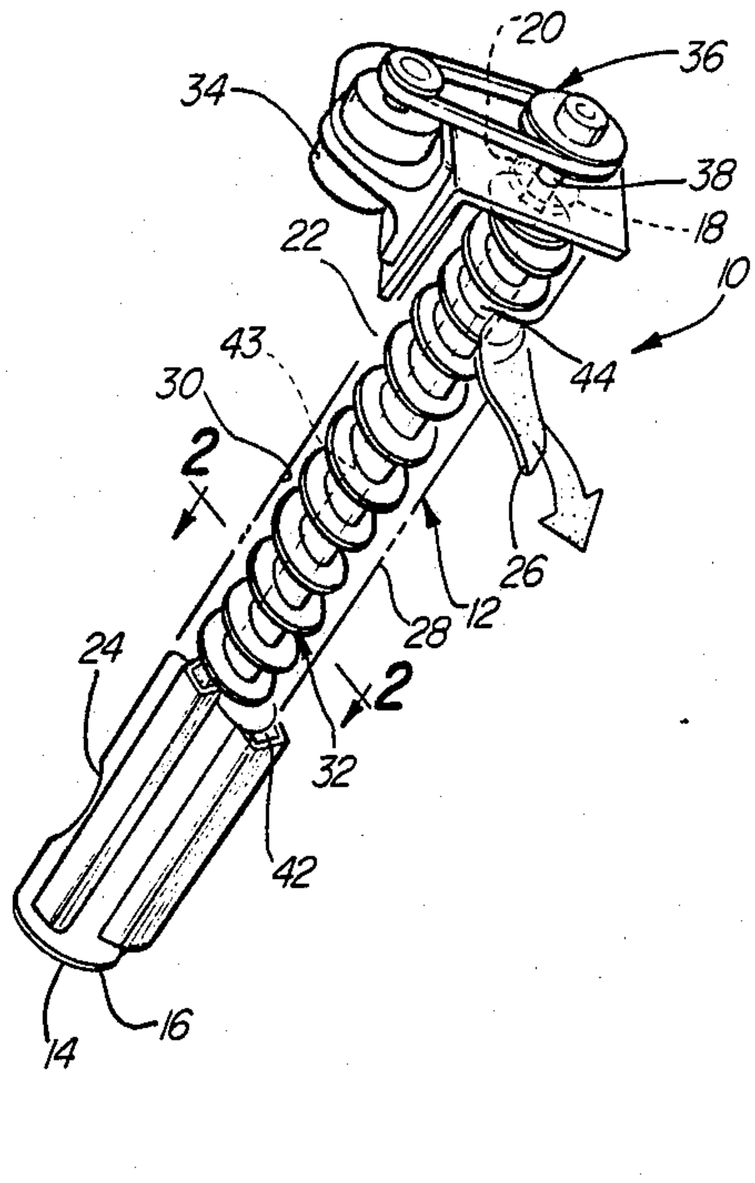
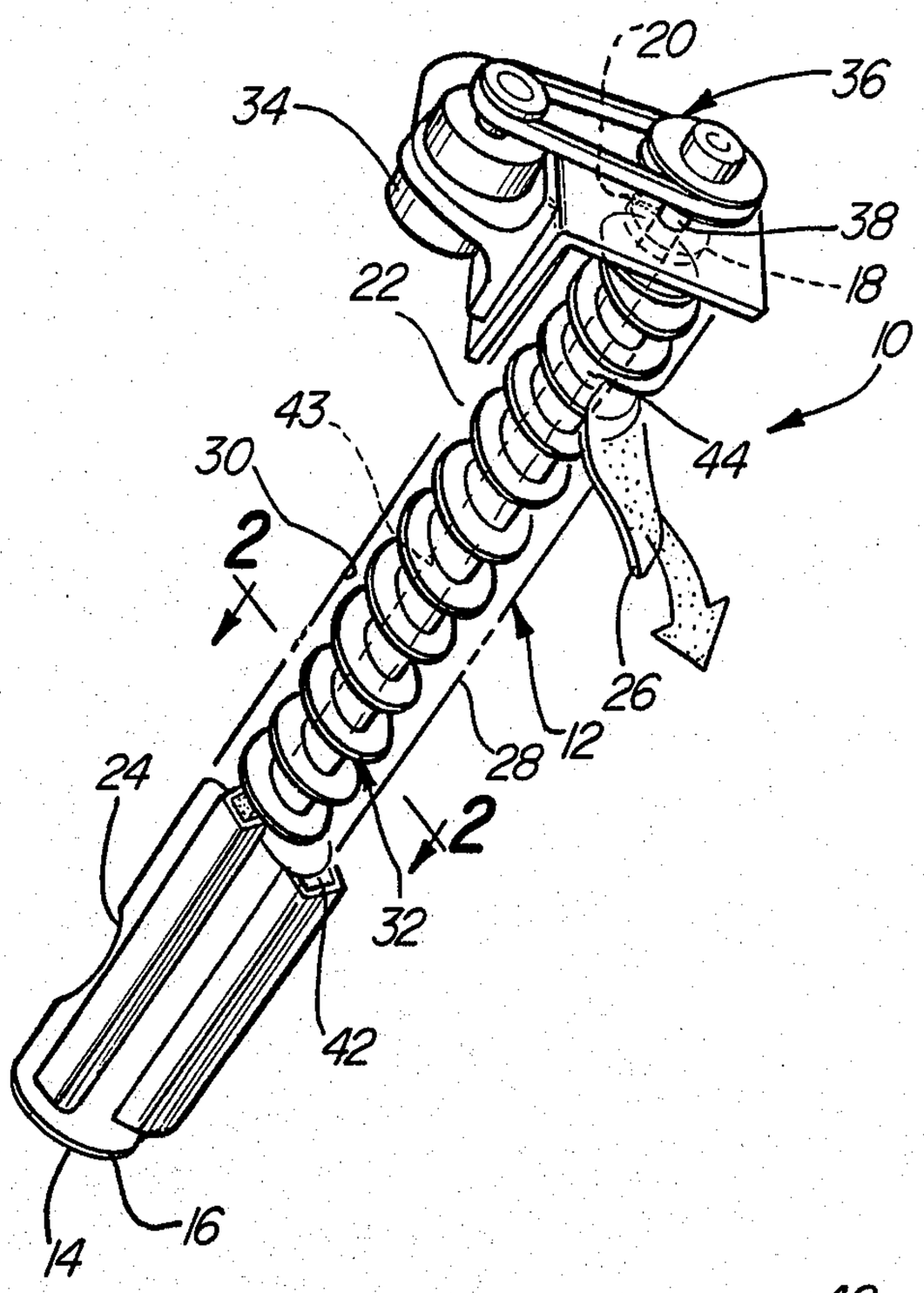
Attorney, Agent, or Firm—Reising, Ethington, Barnard, Perry & Milton

[57] **ABSTRACT**

An apparatus (**10,10'**) for handling articles by magnetic attraction includes a cylindrical casing (**12,12'**) of non-magnetic material having upper (**22,22'**) and lower (**24,24'**) ports. A rotatable helix (**32,32'**) is disposed within the casing (**12,12'**) between the ports (**22,22',24,24'**). Magnetic elements (**42,42'**) are disposed outside of the casing (**12,12'**) for directing a magnetic field through the casing (**12,12'**) and into the casing as the ramp (**32,32'**) rotates. The magnetic field extends along the length of the helical ramp (**32,32'**).

8 Claims, 2 Drawing Sheets




20
36
34
38
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22
10
43
30
2
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26
12
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32
42
16
14

Fig-1

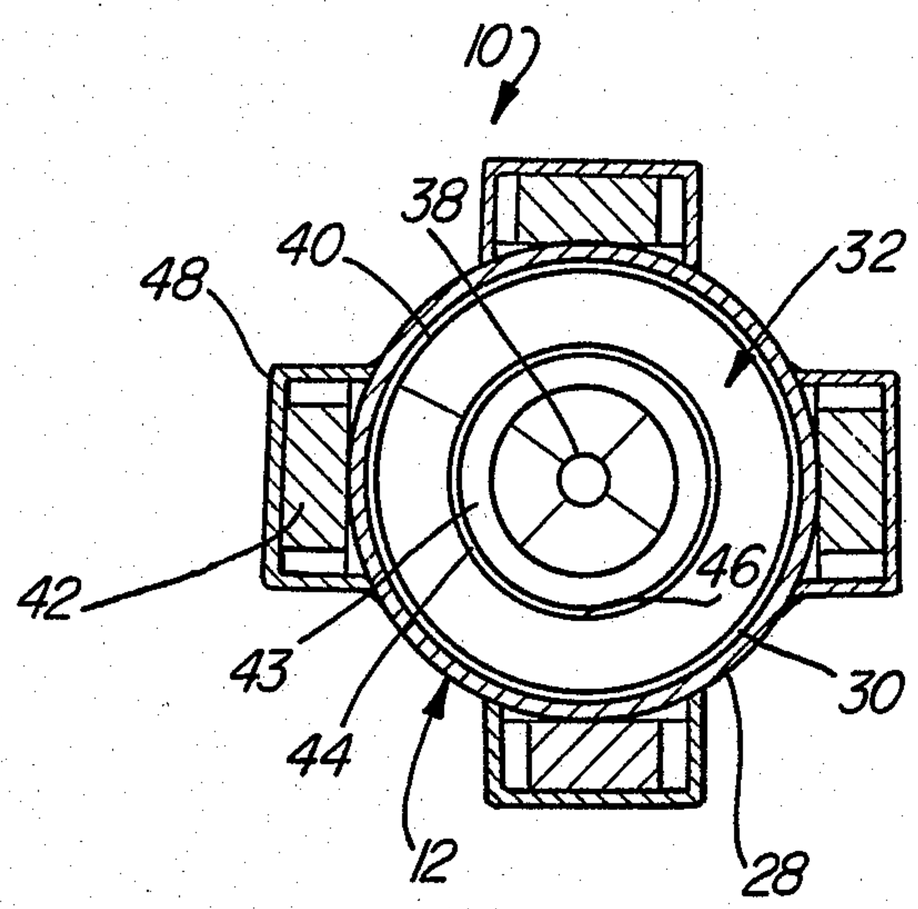
10
38
40
48
32
46
42
43
44
30
12
28

Fig-2

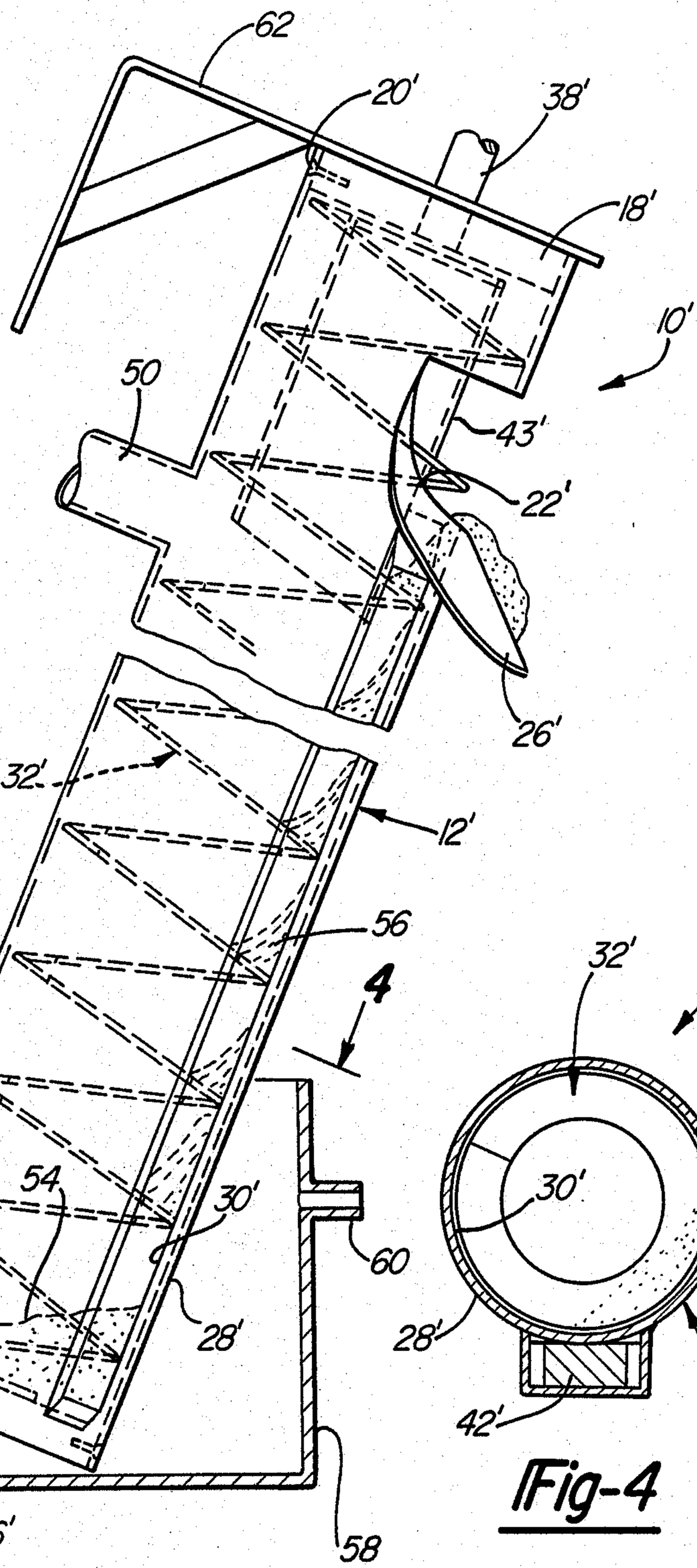
62
20'
38'
18'
10'
50
43'
22'
26'
32'
4
12'
56
4
24'
54
30'
60
52
28'
14'
16'
58

Fig-3

32'
10'
40'
48'
30'
28'
12'
42'

Fig-4

MAGNETIC SEPARATION MACHINE

FIELD OF THE INVENTION

The invention relates generally to article handling apparatus and is particularly concerned with magnetic article sorting, parts handling, and/or parts storage apparatus and systems.

DESCRIPTION OF RELATED ART

In many industrial processes, it is necessary to separate ferrous or magnetically attractive material, from nonmagnetic material. Under certain conditions, it is necessary to separate ferrous metal fines and powders. These fines and powders can be dry and separated from other dry powders. Alternatively, the metal fines and powders can be wet and separated from a liquid.

Material handling problems have been associated with the powdered metal industry and steel shot manufacturers with regard to dry materials as well as the metal grinding equipment industry wherein it is necessary to remove ferrous fine material from a liquid.

Problems with prior art assemblies are that they include multiple parts and are incapable of handling large capacity separations. Prior art assemblies also have problems with being adapted to both elevate and lower collected ferrous material. Further, metering of discharged materials must be accomplished because the assembly is one part of an entire material handling system requiring a metered feed of the ferrous material. Finally, excess liquid from collected material must be discharged. In metal grinding equipment systems. It is preferable to return the clean liquid back to the coolant-/oil system for reuse.

Examples of prior art assemblees which sort magnetic materials are the U.S. Pat. Nos. 3,759,367 to Elliott, issued Sept. 18, 1973; 4,062,443 to Wallace, issued Dec. 13, 1977; and 1,605,117 to Koizumi, issued Nov. 2, 1926.

The present invention may be adapted to be an elevator/lowerator or a collection/separation machine and provides a solution to each of the above mentioned problems of the prior art.

SUMMARY OF THE INVENTION

The present invention provides an apparatus for handling articles by magnetic attraction. The apparatus includes elongated, hollow, cylindrical casing of nonmagnetic material. The casing has upper and lower ports and continuous uninterrupted outer and inner surfaces extending therebetween. A helical ramp is rotatably disposed within the casing between the upper and lower ports and includes an outer edge adjacent to the inner surface of the casing. The ramp and inner surface define a spiral passageway. Magnetic means are disposed outside of the casing for directing a magnetic field through the casing and into the passageway as the ramp rotates. The magnetic field extends along the length of the passageway.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. **1** is a perspective view partially broken away of a magnetic elevator/lowerator machine constructed in accordance with the present invention;

FIG. **2** is a cross sectional view taken substantially along lines **2—2** of FIG. **1**;

FIG. **3** is a cross sectional elevational view of a second embodiment of the present invention; and

FIG. **4** is a cross sectional view taken substantially along lines **4—4** of FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An apparatus for handling articles by magnetic attraction is generally shown at **10** in FIGS. **1** and **2**. Primed numbers are used to indicate like structure between the several embodiments disclosed.

Generally, the apparatus **10** includes an elongated hollow cylindrical casing generally indicated at **12**. The casing **12** is a tube made from nonferrous, nonmagnetic material. The tube **12** is stationary and includes a bottom end plug **14** connected to the casing **12** by connecting screws **16**. A top plug **18** is connected to the top of the casing **12** by connecting screws **20**.

The casing **12** includes an upper port **22** and a lower port **24**. The upper port **22** is a material inlet when the assembly is used as a lowerator and the lower port **24** is used as a material outlet. The lower port **24** is used as a material input and the upper port **22** is used as a material output when the assembly is used as a magnetic elevator. A discharge chute **26** is connected to the port used for discharge to guide the discharged material out from the casing **12**. The casing **12** further includes a continuous uninterrupted outer surface **28** and an inner surface **30** extending between the upper and lower ports **22,24**.

A helical ramp generally indicated at **32** is rotatably disposed within the casing **12** between the upper and lower ports **22,24**. The helical ramp **32** is made from a nonferrous, nonmagnetic material. The helical ramp **32** is rotatable relative to the casing **12**. A motor **34** is operatively connected through a pulley and belt system generally indicated at **36** to a driven rod **38**. The driven rod **38** is operatively connected to the helical ramp **32** to rotate the helical ramp **32** in either a clockwise or counterclosckwise direction.

The helical ramp **32** includes an outer edge **40** adjacent to the inner surface **30** of the casing **12**. The combination of the helical ramp **32** and the inner surface **30** of the casing **12** define a spiral passageway which extends along the length of the casing **12**.

The apparatus **10** includes magnetic elements **42** disposed outside of the casing **12** for directing a magnetic field through the casing **12** and into the spiral passageway as the helical ramp **32** rotates. The magnetic field extends along the length of the passageway. The magnetic field can be supplied by permanent or electromagnetic elements.

The rotation of the helical ramp **32** collects and elevates ferrous material within the casing **12** and discharges the material through the upper port **22** on a metered basis. When the motor **34** is reversed, material fed through the upper port **22** is separated as it is lowered through the casing **12** and discharged at the lower port **24**.

The metered discharge of the material is accomplished by the amount of material held to the inner surface **30** of the casing **12** by the magnetic elements **42** in relation to the RPM of the helical ramp **32**. The

elements in combination meter the discharge of the material elevated or lowered by the rotating helix.

The embodiment in FIG. **1** is used to elevate or lower fines and powders which are dry. The assembly includes a nonferrous, nonmagnetic cylinder **43** defining an inner wall **44** of the spiral passageway. The inner wall **44** is radially spaced inwardly and concentrically from the inner surface **30** of the casing **12**. The tube **43** extends the length of the helical ramp **32** through the center of the ramp **32**. The helical ramp **32** has an inner edge **46** adjacent ot the inner wall **44**.

The discharge of material in the embodiment shown in FIGS. **1** and **2** is also metered by the outer diameter of the nonmagnetic tube **43**. This nonmagnetic tube **43** is welded to the inner diameter or inner edge **46** of the helical ramp **32**. This controlled space between the tubes **12** and **43** at which ever port **22,24** is used for discharge physically forces collected ferrous material out of the magnetic field and onto the discharge ramp **26** for discharge. The embodiment shown operates in a substantially vertical position for use with dry ferrous fines and powders. The device can be operated at any angle, horizontal to vertical.

The apparatus **10** includes magnetic housings **48** extending along the length of the casing **12**. The magnetic elements **42** are disposed within the magnet housings **48**.

A second embodiment **10'** of the invention is shown in FIGS. **3** and **4**. This embodiment can be used as a separation unit for collecting ferrous fines from a liquid carrier. The device **10'** is designed to operate at any angle, horizontal to vertical. The apparatus **10'** includes a casing **12'** having a fluid inlet **50** disposed below the upper port **22'**. The fluid inlet **50** is in fluid communication with the internal passageway defined by the helical ramp **32'** and inner surface **30'** of the casing **12'**. The lower port **24'** providss a fluid outlet.

The lower plug **14'** provides an inner bottom wall **52**. The fluid outlet **24'** is spaced above the bottom wall **52**. The housing below the outlet **24'** defines a substantially cup shaped waste trap below the fluid outlet **24'** wherein waste material **54** which is separated from the ferrous material **56** is contained.

The nonmagnetic tube element **43'** extends only partially down through the helical ramp **32'**. Below the fluid inlet **50**, the helical ramp **32'** is open through its middle, as shown in FIG. **4**. The opening through the center of the helical ramp **32'** allows movement of liquid through the device **10'** while magnetic attraction collects ferrous fines to the inner surface **30'** of the stationary casing **12'**. The casing **12'** is disposed within a fluid trap **58** having a clean liquid discharge port **60**.

The casing **12'** is supported by a frame work **62** which also supports a drive assembly as previously described with relation to the embodiment shown in FIG. **1**. The drive assembly is operatively connected to the driven rod **38'** which is in turn is operatively connected to the nonmagnetic tube **43'**. Nonmagnetic tube **43'** is welded to the inner diameter of the helical ramp **32'**, the tube **43'** extending to a point above or at the fluid inlet **50**.

In operation, ferrous laden liquid enters through the fluid opening **50**. The ferrous material is attracted to the inner surface **30'** of the casing **12'** by the magnetic field directed by the magnets **42'**. The nonmagnetic particles are trapped and collected by the rotating helical ramp **32'**, with the magnetic particles. Thus, both magnetic and nonmagnetic particles are collected for discharge. The clean fluid leaves through opening **24'** into the fluid trap **58** and then is transported back to the system through fluid outlet **60**.

Both embodiments of the present invention includes a single moving part. Although the assembly is small in size, it is large in capacity and is controlled by the RPM of the rotating helcial ramp **32,32'**. The assemblies can be used to elevate as well as lower collected ferrous material. There is metered discharge of the collected materials, the metered discharge being accomplished by the amount of material held to the inner surface **30,30'** of the casing **12,12'** by the magnetic elements **42,42'** in relation to the RPM that the internal helixes turn. Finally, the embodiment shown in FIGS. **3** and **4** drains excess liquid from collected material before discharge and returns clean liquid back to the metal grinding equipment.

The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

While specific embodiments of the invention have been illustrated in the accompanying drawings and described in the foregoing specification, it should be understood that the invention is not limited to the specific construction shown. Alternatives in the construction and arrangement of parts, all falling within the scope and spirit of the invention, will be apparent to those skilled in the art.

What is claimed is:

1. An apparatus (**10,10'**) for handling articles by magnetic attraction comprising; an elongated, hollow, cylindrical outer casing (**12,12'**) of nonmagnetic material, said casing (**12,12'**) having upper (**22,22'**) and lower (**24,24'**) ports and continuous, uninterrupted outer (**28,28'**) and inner (**30,30'**) surfaces extending therebetween; a helical ramp (**32,32'**) of nonferrous, nonmagnetic material rotatably disposed within said casing (**12,12'**) between said upper (**22,22'**) and lower (**24,24'**) ports and including a continuous helical outer edge (**40,40'**) constantly adjacent to said inner surface (**30,30'**), said ramp (**32,32'**) and inner surface (**30,30'**) defining a spiral passageway; and magnet means (**42,42'**) disposed outside of said casing (**12,12'**) for directing a magnetic field through and into said passageway casing (**12,12'**) and into said passageway as said ramp (**32,32'**) rotates, said magnetic field extending continuously along the length of said passageway.

2. An apparatus as set forth in claim **1** further characterized by including a cylindrical inner wall (**44**) spaced radially inwardly and concentrically from said inner surface (**30**), said ramp (**32**) having an inner edge (**46**) adjacent to said inner wall (**44**).

3. An apparatus as set forth in claim **1** wherein said magnetizing means includes a plurality of magnets (**42,42'**) extending along the length of said casing (**12,12'**).

4. An apparatus as set forth in claim **3** including a plurality of magnet housings (**48,48'**) extending along the length of said casing (**12,12'**), said magnets (**42,42'**) being disposed within said magnet housings (**48,48'**).

5. An apparatus as set forth in claim **4** including an outlet (**26,26'**) extending from said upper port (**22,22'**) outside of said magnetic field, said lower port (**24,24'**) defining a material inlet.

6. An apparatus as set forth in claim **1** wherein said casing (**12'**) includes a fluid inlet (**50**) below said upper port (**22'**) and in fluid communication with said passageway, said lower port (**24'**) defining a fluid outlet.

7. An apparatus as set forth in claim **6** wherein said casing (**12'**) includes a bottom wall (**52**), said fluid outlet (**24'**) being spaced above said bottom wall (**52**) and said casing (**12'**) defining a substantially cup shaped waste trap therebetween.

8. An apparatus as set forth in claim **1** wherein said magnetizing means includes four bar magnets (**42**), each of said bar magnets (**42**) extending along the length of said casing (**12**) between said upper (**22**) and lower (**24**) ports, said magnets (**42**) being equally spaced about said casing (**12**).

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